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ABSTRACT

The purpose of these guidelines, intended for the North Carolina public school administrator, the building architect, and the builder, is to facilitate the planning and installation of uniform wiring in a building regardless of the type of equipment that will ultimately be installed. This approach will allow for flexibility in curriculum applications, instructional and administrative management, personnel changes, space utilization, and equipment migration and updates. These guidelines cover: (1) telecommunications (voice, data, and video) wiring requirements; (2) electronic and non-electronic equipment and performance requirements for radio frequency distribution systems; and (3) minimum building standards for mechanical and electrical plans and specifications. Part 1 presents the baseline requirements for cabling; cable paths; telecommunications closet; cross connect requirements; and lightning and surge protection. This part also cites three relevant references: "Minimum Checklist for Mechanical and Electrical Plans"; "State Telecommunications Office Guidelines"; and "Primer for Public School Administrators on Uniform Wiring Service for Telecommunications." Focusing on value-added (option) requirements, Part 2 contains information on voice communication systems; analog-RF-television; satellite delivered television; and television set mounting brackets. Also provided are a list of persons to contact for assistance in applying these guidelines to individual situations and eight diagrams. (ALF)

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ED350982

# Guidelines To Provide Uniform Wiring Service For Telecommunications In North Carolina Public Schools

Dept. of Public Instruction
July 2, 1991
Version 1.1.0

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## OVERVIEW

SCOPE: These guidelines apply to all public school systems within the State of North Carolina for:

1. telecommnications (voice, data, and video) wiring requirements

2. electronic and non-electronic equipment and performance requirements for radio frequency distribution systems

3. minimum building standards for mechanical and electrical plans and specifications.

Unique applications or particular construction circumstances will require individual consultation with appropriate divisions within the Department of Public Instruction. See listing that follows.

INTENT: It is desired to have a uniform wiring plan for voice, data, and video to allow for flexibility in curriculum applications, instructional and administrative management, personnel changes, space utilization, and equipment migration and updates.

PURPOSE: The purpose of these guidelines is to help facilitate the planning and installation of "intelligence" wiring within a building(s) without knowing what type of equipment will ultimately be installed. It is much less expensive and less disruptive to install wiring systems during construction or renovation of a building than after the building is occupied.

HOW TO USE THIS DOCUMENT: After reviewing this document, the administrator may put this into the hands of the architect or builder for use regarding state guidelines. Note that a distinction is made between those requirements which are considered baseline (Part I) and those which will enhance a system above minimum, common wiring requirements (Part II). Also, please note a specific section (9.0) has been set aside for analog television, needed for reception of broadcast programming such as School Television. All references to "video," in this document, refer to digital video, which, as of this writing, does not provide the same quality as analog.

## CONTACTS FOR ASSISTANCE

For assistance in applying these guidelines to individual situations you may contact:


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# PART I

## 1.0 CABLING REQUIREMENTS

1.1 Cable Classes:

1.1.1 Riser Cables: Homerun cables that run between common equipment rooms, mechanical rooms and wiring closets. (See Figure 1.)

1.1.2 Horizontal Cables: Cables that run from wiring closets to user stations and/or classrooms. Connects voice/data equipment with user and/or classroom outlets.

1.2 Cable Sizes/Types

1.2.1 Unshielded cables: (UTP) should be high capacity; 22/24 AWG solid annealed copper conductors insulated with color coded PVC and jacketed with low friction PVC and is UL Listed as type CMR and UL classified as meeting NEC-800-3(b); four UTP for voice; four UTP for data. Run to all telephone/data outlets. Ref.: AT&T #DSW4/22W1000.

1.2.1.1 UTP and/or STP can be used for compressed digital video signals up to 1.544 Mbps (T-1). Verify implementation.

1.2.2 Shielded cables: (STP) should be 22/24 AWG copper; two STP for data. Run to all data outlets. Ref.: IBM Type 1.

1.2.2.1 Cable should satisfy current token-ring requirements or other LAN configurations. There are limitations on the distance from wiring closet to the workstation and the number of workstations attached to the token-ring. Verify limitations and implementation.

1.2.3 Coaxial cable: For RF (analog) Television

1.2.3.1 Riser (trunks) and horizontal (feeds) runs and antenna downleads less than 200-ft. should be RG-6, 75-ohm, copper clad 18 AWG steel center conductor, with foam dielectric, double shielded, 100% sweep tested for transmission and structural return loss and certified. Ref.: Comm/Scope F660BVX

1.2.3.2 Risers and antenna downleads over 200-ft should be RG-11, 75-ohm, copper clad 16 AWG steel center conductor, with foam dielectric, double shielded, 100% sweep tested for transmission and structural return loss and certified. Ref.: Comm/Scope F1160BVR

1.2.3.3 Cabling between television sets and wall outlets should match 1.2.3.1 above. If RG-59, 75-ohm coax is used, it shall have equal or better specs.

1.2.3.4 Cabling in active plenums without conduit may be .500 aluminum sheathed hard shell. Copper clad aluminum center conductor, foamed Teflon fluorinated ethylene propylene dielectric. Ref.: Comm/Scope 2311

1.3 Cable Integrity

1.3.1 Cables should be installed with sufficient bending radius so as not to kink, shear, or damage binders.

1.3.1.1 Bend radius should be at least eight times the OD of the cable.

1.3.2 All buried and underground cable should be jelly filled. Once jelly filled cable enters a building, it should be properly plugged and sealed to prevent leakage.

1.3.3 Riser and horizontal RF television cables that are below grade should also have flooding compound. Ref.: Comm/Scope F660BEF and/or F1160BEF

1.3.4 All buried and underground cables should be placed at a minimum depth of 24 inches as measured from the top of the cable, unless otherwise specified.

## 2.0 CABLE PATHS

2.1 Conduit

2.1.0 Planned capacity should be for 100% redundancy.

2.1.1 Entrance conduit size should vary with number of lines entering building. Size should be a minimum of two inches.

2.1.2 Entrance conduit should extend beyond any paved areas.

2.1.3 Riser conduit should be at least three inches.

2.1.3.1 In multilevel installations, non-continuous four inch sleeves may be used between levels instead of conduit.

2.1.4 Horizontal conduit should be 1 inch or greater.

2.1.5 Conduit used in exposed areas, under floor and in masonry walls may be rigid metal, intermediate metal and/or schedule 80 rigid non-metallic (PVC).

2.1.5.1 When surface mounting, metal raceway (plug mold) may also be used. Metal raceway to be mounted below 72-inches A.F.F., should be specified so as not to be damaged by chairs, tables and other items of furniture.

2.1.6 Conduit used in concealed areas such as above the ceiling, in sheetrock walls and in Tele-Power pole installations, may be electric metallic tubing and/or electric non-metallic tubing.

2.1.6.1 In active plenums, the NEC should be followed when specifying conduit material.

2.1.7 Pull boxes should be installed no further than every 100 feet for long conduit runs.

2.1.8 There should be no more than 270-degrees of turns between pull boxes.

2.1.9 A pull string should be left in each conduit to facilitate any future cable installations.

2.2 Wireways

2.2.0 Wireways and cable trays are recommended instead of conduit to carry all low voltage cabling.

2.2.0.1 Wireways should be used in all active plenums. Cable trays may be used if return air is ducted.

2.2.1 Wireways should be sized according to the number of cables running through.

2.2.1.1 Planned capacity should be for 100% redundancy.

2.2.2 Wireways should run overhead from equipment rooms and passing within the area of all classrooms, office clusters, and any other location where there will be voice/data/video outlets.

2.2.3 Wireways should have hinged covers along one side. There should be one opening in the bottom every 60 inches. Ref.: The Austin Co.

2.2.4 In every classroom and in office clusters, there should be a 12 x 12 junction box to the side of and connected to the wireway.

2.2.4.1 The junction box should be located above the ceiling and within the 100 square feet around the main entrance to the room.

2.2.4.2 All conduit from voice/data/video wall boxes within the room or office cluster should connect to the junction box.

2.2.4.3 Resealable access points through fire walls should be provided.

2.2.5 When surface metal raceway is utilized, the power conductors should not be in the same raceway section with the voice, video or data transmission conductors. Approved dividers should be used in surface raceways to separate the power wiring from the others, or separate surface raceways may be used for each.

2.2.6 For in-floor areas of new buildings where concrete slabs are the floors, in-floor systems known by various manufacturers as either subway in-floor, trench duct or underfloor duct can be used in classrooms with the traditional seating arrangement of desks in rows. These systems can be compartmentalized to separate the power wiring from other wiring.

2.2.6.1 Trench duct should be connected to the above ceiling junction box by conduit sized by the number of cables needed plus redundancy.

2.2.7 Cable tray should be used over equipment racks and backboards in equipment rooms with a turn down of ladder tray into the rack.

2.3 Elevator shafts should be excluded as possible locations of all such conduit and/or wireways as per NEC.

2.4 Wall Boxes

2.4.1 Wall boxes for voice/video/data should be standard 4 x 4 extra deep. Boxes may be fitted with a 2 x 4 plaster ring. See figures 2-4 for examples of wall box face plates containing jacks for all three applications. If separate wall boxes for voice (telephone), video (digital video), and data (computer networking) are to be used, then they should be placed in relation to each other appropriately for the planned use.

2.4.1.1 Boxes for voice/data/video should be mounted no higher than 18 inches A.F.F. except when mounting above a countertop.

2.4.1.2 Boxes for voice should be mounted at 18, 40, or 48 inches depending on application. Conduit to above ceiling junction box may be 1/2-inch.

2.4.2 Conduit from wall boxes to above ceiling junction box should be at least 1-inch (2.1.4) except where noted.

2.4.3 Wall boxes for classroom television should be a standard 4 x 4 box with a 2 x 4 plaster ring; or use a standard 2 x 4 duplex box.

2.4.3.1 Box should be installed vertically with 3/4-inch conduit to the above ceiling junction box.

2.4.3.2 Wall box should be installed 72-80 inches A.F.F. if the television set is to be wall or ceiling mounted.

2.4.3.3 Wall box should be installed 24-48 inches A.F.F. if the television set is to be movable.

2.5 Wall Box Covers

2.5.1 Voice/data/video boxes should be covered with a common face plate with a data connector, a RJ-11 jack, and a RJ-45 jack.

2.5.2 Classroom television boxes should be covered with a standard stainless steel duplex plate.

2.6 AC Power

2.6.1 120 VAC power within 12 inches of every voice/data outlet should be provided.

2.6.2 AC power and voice/data/video and television should never be housed in the same box, even with a metal partition.

2.6.3 Voice only outlets at 48 inches A.F.F. do not need AC Power.

## 2.7 Fiber Optic Considerations

2.7.1 Innerduct: A sleeved physical channel with each end capped should be provided for fiber optic cable which may be added at a future date. This is to be within the conduit system. The innerduct should contain pull string.

## 3.0 TELECOMMUNICATIONS CLOSET

3.1 The purpose of the closet is to house the equipment associated with the telecommunications wiring system. There should be at least one closet in every building (excluding storage) of a school complex.

3.2 The closet should contain the mechanical terminations for a portion of the horizontal wiring system and a portion of the riser wiring system. The closet should also provide support for the passive and active devices used to interconnect the two systems.

3.3 Closet Size:

3.3.1 Closet space should be adequate to meet current communication needs as well as provide for future growth.

3.3.1.1 The main telecommunications closet should be large enough to house the associated equipment, perhaps a LAN controller, LAN racks, future fiber optics equipment, and C.O. lines in accordance with the local telco requirements for space per line.

3.3.2 The main closet should be at least 8x10 ft.

3.3.3 The satellite closets should be at least 6x10 feet.

3.3.4 Wall space should be provided that is adequate for termination equipment, and strain-reliefing cables.

3.3.4.1 Eight inches on either side of a corner should be considered unusable.

3.4 The main closet should be located as near as possible to the center of the riser cable system.

3.5 Closet location should not be subject to flooding.

3.5.1 Waterproof ceilings and floor drainage should be installed.

3.5.2 Closet should be located away from plumbing and other water susceptible areas.

3.6 Closet should be completely finished including heating and air conditioning.

3.6.1 Ceiling height should provide a minimum clear space of 8 feet. Closet walls should extend up to the structural ceiling.

3.6.1.1 Closets should have a two-hour fire rating. There should be a smoke and ion detection system inside the closet. If sprinklers are available, they should be placed outside of closet.

3.6.2 Closets should have vinyl tile floors. Carpet or uncovered concrete does not meet this recommendation.

3.6.3 Overhead lighting should be coordinated with overhead wireways and cable trays and positioned so as not to cause shadows on backboards.

3.6.3.1 Switch for overhead lighting should be outside the closet. Switch should be keyed with a red "In Use" indicator on cover plate.

3.6.4 Doorways should be at least 36 inches wide and 6 feet 8 inches high.
3.6.4.1 Doors should open outward
3.6.4.2 There should be no center posts or thresholds.
3.6.4.3 Closet doors should have locks. Distribution of keys should be restricted.

3.7 The maximum distance between the actual mechanical termination and the user's work station should be 295 feet. This includes cross-connect jumpers and patch cables.

3.7.1 Establish satellite telecommunication closets and establish a riser or backbone wiring system.

3.7.2 Satellite closets should meet the same specifications as the main closet.

3.7.3 In multi-story buildings, satellite closets ought to be located directly above the main closet and connected with several 4-inch sleeves through the floor.

3.8 Manufacturer's specifications for exact space, power, and cooling requirements should be consulted.

3.8.1 Any of the above recommendations should be adjusted to match manufacturer's specifications.

## 4.0 CROSS CONNECT REQUIREMENTS

4.1 For cross connect of unshielded voice cabling (associated with electronic PBX), 3 feet of linear wall space should be provided for every 50,000 square feet of building space.

4.1.1 One or more fire treated, painted 3/4-inch plywood backboards should be secured to the walls.

4.1.2 A 120 VAC, 20 amp, electrical outlet should be provided within three feet of cross connect blocks.

4.1.3 Sufficient floor space in front of cross connect block area should be provided to locate equipment rack containing PBX equipment.

4.1.4 During early stages of building design, the telephone company building wiring specialist should be consulted.

4.2 For cross connect of unshielded data cabling, EIA Standard 19-inch racks should be provided.

4.2.1 One rack for each 100 drops. (Single riser or horizontal cable)

4.2.2 Allow for one additional rack.

4.2.3 Anchor racks to floor.

4.2.4 Provide one 120 VAC, 20 amp circuit into each rack.

4.2.5 Cross connect, or punchdown, blocks should be configured for 19-rack mounting and may be prewired for RJ-11/RJ-45 patching.

4.3 For cross connect of shielded data cabling, a 72-inch EIA Standard 19-inch rack should be provided for Type 1 shielded cable distribution panels and token-ring interfaces. Ref.: IBM cabling system.

4.3.1 One rack for each 100 drops.

4.3.2 Allow for one additional rack

4.3.3 Anchor rack(s) to floor.

4.3.4 Provide two, 120 VAC, 15 amp, circuits into rack.

4.4 Cross Connect Field Overview: Panels shall consist of multiple 17" x 20" backboards (183B) and/or multiple half-backboards (183A) which are 8 1/2" x 20". These will have mounted on them 66M1-50 type connecting blocks and with two-four pair cables at each outlet. This provides a 48 outlet capacity per backboard or 24 outlet capacity for a half-backboard. Patch cable type (using #110P connecting blocks) may be used at some locations and punch down type (using #110A or 66M1-50 connecting blocks) at other locations depending on need and expertise of personnel that can use patch cables. Access clearance for front and sides of backboard should be 3 feet. Each backboard should be color coded as follows (Also see Figure 5):

| Application | Color | Size | Backboard # |
|---|---|---|---|
| Stations | blue | 8 1/2 x 20 | 183A1 |
| Central Office | green | 8 1/2 x 20 | 183A2 |
| PBX Trunks | purple | 8 1/2 x 20 | 183A4 |
| Data | yellow | 8 1/2 x 20 | 183A5 |
| Stations | blue | 17 x 20 | 183B1 |
| Central Office | green | 17 x 20 | 183B2 |
| Alarms | red | 17 x 20 | 183B3 |
| PBX Trunks | purple | 17 x 20 | 183B4 |
| Data | yellow | 8 1/2 x 20 | 183A5 |
| Spooler | white | 17 x 6 1/2 | 187B1 |

4.5 Wireways or cable trays should be installed over the racks with turn downs into each rack.

4.6 Patch cables should be provided as needed for the above cross connects.

## 5.0 LIGHTNING AND SURGE PROTECTION

5.1 National Electrical Code Adherence:

5.1.1 All telephone communications circuits should be installed in accordance with Article 800 of the National Electrical Code, NFPA 70, latest edition.

5.1.1.1 Exception: The "Protective Devices" requirements of paragraph 800-2 apply to all outside circuits of any length whether aerial or underground. All arrestors should be gas tube type, tested and listed per ANSI/UL 497. They should be installed on each telephone circuit entering a building as close as practical to the point of entry.

5.2 Protectors:

5.2.1 All protectors should be grounded using AWG 12 (minimum) copper wire for single line or double line, AWG 10 for three through six lines, and AWG 6 for seven or more lines. This conductor should be connected to the building's Grounding Electrode System described by NEC 250-81 in accordance with NEC 800-31(b)5. The protector should be 189B1-gas type or equal.

5.3 Grounding:

5.3.1 Multi-line cable with separate shield should be grounded per "5.2" above, where it enters any building, but by separate conductor. The cable shield should be removed for a length of at least 12 inches on the equipment side of this ground connection, or non-shield cable used from this point to the equipment.

5.3.2 The telecommunications equipment should be Single Point Grounded. The SPG consists of bonding together, at one point, the station equipment grounding connection, the green power wire, the inside cable shield (if any), and the station protector grounding conductors (if the protectors are co-located with the equipment). Where the protectors are not co-located with the equipment, a "couple bond conductor" of #10 AWG copper should be run from the SPG along the incoming cable to the station protector grounding terminal.

5.4 Surge Protectors:

5.4.1 The AC power circuit feeding the electronic station should be provided with a surge protector. No other equipment should be connected to this circuit.

5.5 Sneak Current Fuses:

5.5.1 Certain station equipment (usually with circuits of 100 Ohms or less impedance to ground) may require "Sneak Current Fuses" to prevent equipment failure, line hazard, and danger to personnel.

## 6.0 RELEVANT REFERENCES

6.1 A Minimum Checklist for Mechanical and Electrical Plans is available through the Department of Public Instruction's School Planning Section.

6.1.1 This minimum checklist covers various electrical installation recommendations and requirements for service entrance feeders and equipment, grounding, panelboards, lighting, motor connections, exit and emergency lighting fixtures and illumination recommendations.

6.1.2 The purpose of this Checklist is to:

- assist electrical and mechanical engineers by providing a compilation of the best methods for installing mechanical and electrical service in school facilities.
- to avoid "reinventing the wheel."

6.1.3 The life cycle cost analysis approach is used in this document.

6.2 STO-1000 - State Telecommunications Office Guidelines, Revision 05.01 is available from State Information Processing Services, 3700 Wake Forest Road, Raleigh, NC 27609.

6.2.1 These guidelines served as a reference for this document and include supplementary information on handicap considerations, elevator telephones, and budgetary guidelines for planning a telecommunication system.

## 7.0 PRIMER FOR PUBLIC SCHOOL ADMINISTRATORS ON UNIFORM WIRING SERVICE FOR TELECOMMUNICATIONS

7.1 A Primer for Public School Administrators on Uniform Wiring Service for Telecommunications is being developed, with anticipated release in fall 1991.

7.2 The purpose of this primer will be to:

- provide background information/general considerations to use in conjunction with Guidelines to Provide Uniform Wiring Service for Telecommunications for North Carolina Public Schools
- provide examples of telecommunications applications in the classroom and administrative settings.

# PART II

## 8.0 VOICE COMMUNICATION SYSTEM (Optional)

8.1 System Description:

8.1.1 A fully operating, integrated communications network based upon a private branch exchange system that uses digital switching and stored program control to carry out all communications functions. As options, these communications functions may include sound, clock program, and intercom. The features offered by this system should be implemented and controlled by software programs that can be changed and expanded as customer needs evolve.

8.1.2 The system should complete its own maintenance check using built-in, self-diagnostic routines. These routines should be programmed to run every 24 hours at a time specified by the customer.

8.1.3 The classroom/media center interface should be a global switching, dual-tone, electronic network consisting of multiple amplified intercom channels, DTMF telephones, classroom/media center and staff speakers and/or telephones, NMOS microprocessor and memory, solid state logic and sensing, and should also provide two-wire balanced transmission with dial tone, ringing, and busy signal capabilities to all stations.

8.1.4 The system should lend itself to expansion by simple addition of modules for a total capacity of 500 stations.

8.1.5 The central switching system should have the capability of controlling all public and inter-school telecommunications. The unit should decode all dial functions, using normal dial tone phone.

8.1.5.1 The system should be connected to the public telephone trunk lines through FCC approved central office interface.

8.1.5.2 Public telephone calls should be received by the system and routed to the designated attendant console and/or to the designated telephone.

8.1.5.3 The central switch should provide for automatic switching of the talk path to a telephone mode, during the course of a call, should the telephone associated with the speaker in use be lifted from its cradle.

8.1.5.4 The switch should provide for two-way telephonic communication from any classroom or staff phone to any office administrative phone.

8.1.5.5 The switch should provide for two-way telephonic communication between any two phones in the system or any combination of phones in the system.

8.1.6 Classroom extension numbers should all be programmable and assignable with any number from 001 to 999. Any extension should have the capability of being reassigned at any time, and it should not be dependent on wiring or circuit numbers.

8.1.7 If selected as an option, the user programmable master clock can be incorporated into this system, provide for four separate schedules and four separate zones, and interface with all secondary clocks, analog or digital.

8.1.8 An uninterruptable power supply should be included to provide for a full operating communications network as specified for a minimum of 20 minutes under full load.

8.2 Administrative phones:

8.2.1 The digital PBX programmable data telecom network should provide the following features, functions, and provisions for:

* recalling unanswered calls back to operator's console
* call forwarding all calls to any predetermined location inside the school
* call forwarding all calls to any predetermined location outside the school
* one button seizure of calls directed to an unattended station.
* transferring calls to a determined extension number by pressing a transfer key and dialing the extension number.
* conferencing up to five calls together
* placing a call on hold
* making calls directly and receiving a reply from any classroom by touch tone dialing the room's architectural number
* connecting private lines to individual phones.

8.2.2 Provisions should be made for any phone location to interface with a data terminal. This interface device should be capable of connecting to an industry standard RS-232 connection. The transmission speed-through switch should allow for up to 19.2 baud. The data transmission should be simultaneous with voice transmission.

8.2.3 Facilities for month/day/time display on built-in, alphanumeric, 2-line by 40-character LCD should be available. This display should provide for presentation of ISDN network features.

8.2.4 Facilities for a user to relocate his own phone to a compatible type location without outside intervention from the equipment supplier should be available.

8.3 Main Console Phone:

8.3.1 The digital PBX programmable data telecom network should provide the following features, functions, and provisions for:

* Recalling unanswered calls back to the operator's console.
* one-button seizure of calls directed to an unattended station.
* call forwarding all calls to any predetermined location inside the school.
* automatically sending incoming calls to an alternate phone if they remain unanswered by the operator for a predetermined amount of time.
* making calls directly and receiving a reply from any classroom by touch tone dialing the room's architectural number.

8.3.2 Facilities should include a 4-line by 40-character LCD which indicates essential information required for processing calls and personalized call answering. The alphanumeric display should provide for immediate viewing of all source and destination information.

8.3.3 Facilities should include automatic notification to a user engaged in a call that a second call has been sent to that station. User should be able to answer second call without disconnecting first call.

8.3.4 Facilities for loop keys and incoming call indicator keys should allow the attendant to handle calls in sequence or to prioritize answering for specific trunk groups.

8.3.5 Facilities should include notifying the console operator of a minor system malfunction, as well as notifying the operator of a major system malfunction or that an emergency transfer has taken place.

8.3.6 Facilities should include for attendant control of access to designated trunk groups.

8.3.7 Facilities should include a microprocessor to provide directory and messaging functions and dial-by-name features.

8.4 Classroom/Media Center Telephone Handsets:

8.4.1 Should be a standard, off-the-shelf, hard wired, tone dialing wall mounted instrument.

8.4.2 Facilities for direct dialing two-way private telephone communications between all locations within the school should be available.

8.5 Central PABX:

8.5.1 The central PABX should be capable of serving the handset functions listed above and also have the following capabilities:

* centralized attendant answering
* restricting use of the phone system on a per phone, per trunk basis
* store diagnostic results, traffic statistics, software error, and other system messages
* transfer to a dedicated alternate source of power in the event there is a commercial power failure
* charging incoming or outgoing calls to a specific account code
* connecting T1 carrier lines directly
* connecting two-wire DTMF trunks
* connecting two-wire pulse trunks
* connect two wire ring down
* connecting four wire digital
* automatic route selection of outgoing calls
* sixteen internal links for 16 unrestricted simultaneous telephone communications

8.6 Undesirable features:

8.6.1 The use of a press-to-talk or talk-listen switch.
8.6.2 Systems without automatic queuing
8.6.3 Systems with pulse dialing
8.6.4 Architecture that cannot be user programmed

8.7 Testing:

8.7.1 Tests to all systems should be performed under the direct supervision of manufacturers' representatives of accredited agencies for all specified equipment and services.

8.7.2 Minimum acceptable signals, levels, audible qualities should be determined to be acceptable in the Owner's representative and Engineer's opinion.

8.7.3 All specified test reports should be submitted to the Owner.

8.8 Training:

8.8.1 Personnel, as designated by the Owner, should be trained in full operation of all system functions and features.

8.8.2 All training should be conducted by the supplying agency on site with hands-on training on an operational system.

## 9.0 ANALOG - RF - TELEVISION (Optional)

9.1 Overall System Performance Requirements:

9.1.1 4 dBmV minimum output at all taps, including test points, for each channel.

9.1.2 15 dBmV maximum output at all taps, including test points, for each channel.

9.1.3 20 dB minimum isolation between taps.

9.1.4 Overall S/N ratio of 40 dB for a 6-MHz bandwidth.

9.1.5 Flatness or response: 3 dB maximum peak to valley across any one 6-MHz bandwidth and 5 dB maximum peak to valley across the system bandwidth.

9.1.6 Variations in ambient temperatures of -20 to +60 degrees C. should not cause more than ± 1dB change in outlet voltage.

9.1.7 The system should provide reception quality at each outlet equal to or better than received with individual antennas in the particular area.

9.1.8 The system as designed and installed should provide for the distribution of RF signals over a 12 to 300 MHz bandwidth.

9.1.9 The system as designed should provide for return channel capability over a 12 to 50 MHz bandwidth from any tap in the system.

9.1.10 See Figures 6-8:

- "Recommended RF Television Headend Design"
- "Typical RF Distribution System"
- "Add-ons for Local Origination"

9.2 Antenna: Terrestrial

9.2.1 Hard drawn aluminum alloy construction.

9.2.2 Mounted approximately 30-feet above ground

9.2.3 Clear of natural and man-made obstructions.

9.2.4 Spaced to prevent "inter-antenna" interference

9.2.5 UHF = Z-Matched, 75-ohm, 10 element, single channel

- Gain: ≥10.5 dB
- Front to Back Ratio: ≥17.2 dB
- Ref.: Blonder-Tongue BTY-10-U
- Ref.: Catel PR-450U

9.2.5.1 Mounted 4 to 8 feet above roof line

9.2.6 VHF-LO = Z-Matched, 75-ohm, 5 element, single channel
- Gain: >9 dB
- Front to Back Ratio: ≥20 dB
- Ref.: Blonder-Tongue BTY-5-Series

9.2.6.1 Mounted 6 to 10 feet above roof line

9.2.7 VHF-HI = Z-Matched, 75-ohm, 10 element, single channel
- Gain: ≥11 dB
- Front to Back Ratio: ≥21 dB
- Ref.: Blonder-Tongue BTY-10-Series

9.2.7.1 Mounted 6 to 10 feet above roof line

9.3 Pre-Amps:

9.3.1 75-ohm, input & output

9.3.2 Heavy-duty die-cast aluminum construction

9.3.3 Mount on the antenna support structure

9.3.3.1 Mount within reach from a standable surface

9.3.4 UHF:

9.3.4.1 Noise Figure: <3.5 dB

9.3.4.2 Gain: >20 dB

9.3.4.3 Ref.: Blonder-Tongue CMA-Uc

9.3.5 VHF:

9.3.5.1 Single channel

9.3.5.2 Noise Figure: <3.0 dB

9.3.5.3 Gain: >25 dB

9.3.5.4 Ref.: Blonder-Tongue CMA-b

9.4 Channel Processors: Frequency Agile

9.4.1 Input frequency range: 54 MHz to 300 MHz; 470 MHz to 890 MHz

9.4.2 Single channel, phase lock and crystal control
7.4.2.1 Meets F.C.C. Docket 21006 frequency stability requirements

9.4.3 Carrier to Out-of-Band noise ratio: >77dB

9.4.4 Adjacent channel rejection: >60dB

9.4.5 IF dual SAW filtering

9.4.6 RF power output level: >60dBmV

9.4.7 In and out channels selectable by front panel DIP switches.

9.4.8 Ref.: Olson Technology LCP-500-H

9.5 Modulators: Single Channel, Frequency Agile

9.5.1 Output frequency range: 54 MHz to 444 MHz
7.5.1.1 selectable by front panel DIP switches.

9.5.2 Carrier to Out-of-Band noise ratio: >77dB

9.5.3 Spurious output ratio: >60dB

9.5.4 IF SAW filtering

9.5.5 IF Single loop: Visual carrier +35dMmV @ 45.75 MHz

9.5.6 RF power output level: >60dBmV

9.5.7 Ref.: Olson Technology LCM-500-H

9.6 Combining Network: Amplified, Headend

9.6.1 Frequency Range: 50-300 MHz

9.6.2 Mix 8 BB channels to 1 BB output

9.6.3 Amplified output level: 57dBmV

9.6.4 Cross Modulation: -46 dB

9.6.5 Isolation between ports: >25 dB

9.6.6 Terminate all unused ports

9.6.7 Ref.: Blonder-Tongue OCA-8

9.7 Test Points:

9.7.1 Directional coupler fed

9.7.2 Double isolate if necessary

9.7.3 One on each antenna downlead

9.7.4 Two on combined headend output

9.7.5 Signal level between +3dBmV and +15dBmV.

9.7.6 Accessible from outside headend cabinet

9.8 Distribution System:

9.8.1 Line-drop configuration (Loop-thru is unacceptable)

9.8.2 Directional coupler tapoffs
- Bandwidth: 5-500 MHz
- Tap to Output isolation: >25 dB
- -80 dB radiation shielding
- Ref.: Blonder-Tongue CRT Series

9.8.3 Splitters/Combiners
- Bandwidth: 5-500 MHz
- Isolation: >27dB
- -80 dB Radiation Shielding
- Ref.: Blonder-Tongue CRS Series

9.8.4 All cable runs should be splice free.

9.8.5 Feeder lines terminated with manufactured fittings

9.8.6 Walltaps:
- Type F or G/F connectors at all taps.
- Feedthru connectors on steel frames
- Ref.: Blonder-Tongue V1-GF-FT

9.8.7 Trunk lines and Feed lines:
- No excess cable in runs
- may use RG-6 coax
- may use .500 hardshell in plenums
- Select couplers and splitters to match hardshell

9.9 "Pigtails":

9.9.1 Constructed from RG-6 or RG-59
- RG-6 should match system cable
- RG-59 should have equal or better specs

9.9.2 One end should be fitted with an "F" connector

9.9.3 One end should be fitted with a quick disconnect connector
- Ref.: General Instrument SF-56 or SF-59

9.10 Headend Cabinet:

9.10.1 Standard EIA 19-inch rack panel design, 24-in. deep, 72- to 77-in. high.

9.10.2 Steel, ventilated, lockable

9.10.3 4 flat shelves, 8-inches apart mounted in lower half of cabinet

9.10.4 2 power strips, each on dedicated, 15-amp circuit.
9.10.4.1 Should have surge protectors on each circuit.

9.11 Classroom TV Wall Box:

See: 2.4.3 and 2.5.2

9.12 NOTE: For interactive, instructional television, there should be a telephone line jack available in the classroom near the TV Wall Box.
(See 8.0 VOICE COMMUNICATION SYSTEM)

## 10.0 SATELLITE DELIVERED TELEVISION (Optional)

10.1 Antenna: Satellite

10.1.1 Ku-band only reflector should be ≥ 2.4 Meters.
- should be solid metal, aluminum or steel
- gain should be ≥ 49 dBi
- 3 dB beam width, 0.6 degrees
- f/D ratio should be 0.3-0.45
- 85 MPH wind survival
- 10 inch snow load
- 2 inch ice load

10.1.2 C-band or combination reflector should be ≥ 3.4 meters.
- should be solid metal; aluminum or steel
- Gain should be ≥40 dBi
- 3 dB beam width, 1.7 degrees
- f/D ratio should be 0.3-0.45
- 85 MPH wind survival
- 10 inch snow load
- 2 inch ice load
- Ref.: Prodlin

10.1.3 Antenna assembly should be installed and mounted according to the manufacturer's specifications.

10.1.3.1 Horizon-to-Horizon motorized actuator polar mount

10.1.3.2 Actuator should be able to position antenna to receive Spacenet 2 at 69 degrees west and Aurora 1 at 143 degrees west.

10.1.3.3 Installation should be capable of surviving as a minimum 85 MPH winds.

10.2 Feedhorn(s) should be selected to match reflector ratios

10.2.1 Feedhorn should be mounted with at least a tripod.

10.3 LNB's should be L-band and match the characteristics of the receiver.

10.3.1 LNB/feedhorn combination should be polarized on both Ku and C-bands

10.3.2 C-band LNB should be ≥70°

10.3.3 Ku-band LNB should be ≥170°

10.3.4 Polarity isolation should be ≥35 dB.

10.3.5 There should be a separate transmission line for each LNB.

10.3.6 Transmission line should be RG-6 TVRO or equivalent.

10.4 Satellite Receiver:

10.4.1 Receiver should have a L-band input (950-1450 MHz)

10.4.2 Should be capable of tuning the standard 24 channel C-Band format plus the half transponder capability for Ku-Band.

10.4.3 Receiver should have two separately tunable audio channels capable of receiving both wide and narrow bandwidth subcarriers between 5.0 and 8.5 MHz.

10.4.4 The receiver may be compatible with "Videocipher" and "B-Mac" descramblers.

## 11.0 TELEVISION SET MOUNTING BRACKETS (Optional)

11.1 Can be ceiling or wall style for 25- to 27-inch set

11.2 Should be yoke bracket design with full bottom tray

11.3 Location

11.3.1 Mount so bottom of set is 72-inches A.F.F.

11.3.2 Mount on front classroom wall toward window wall

11.3.2.1 If possible, back of TV set should face windows

11.4 Install according to the manufacturer's specifications

11.5 Ref.: The following mounts

- Lucasey wall model DSCM2333
- Bretford wall model TVM3
- Bretford wall model TVM4
- Peerless wall model 1470-173
- Peerless wall model 1471-234
- Bretford ceiling model TVM1
- Peerless ceiling model 1450-153
- Peerless ceiling model 1451-234

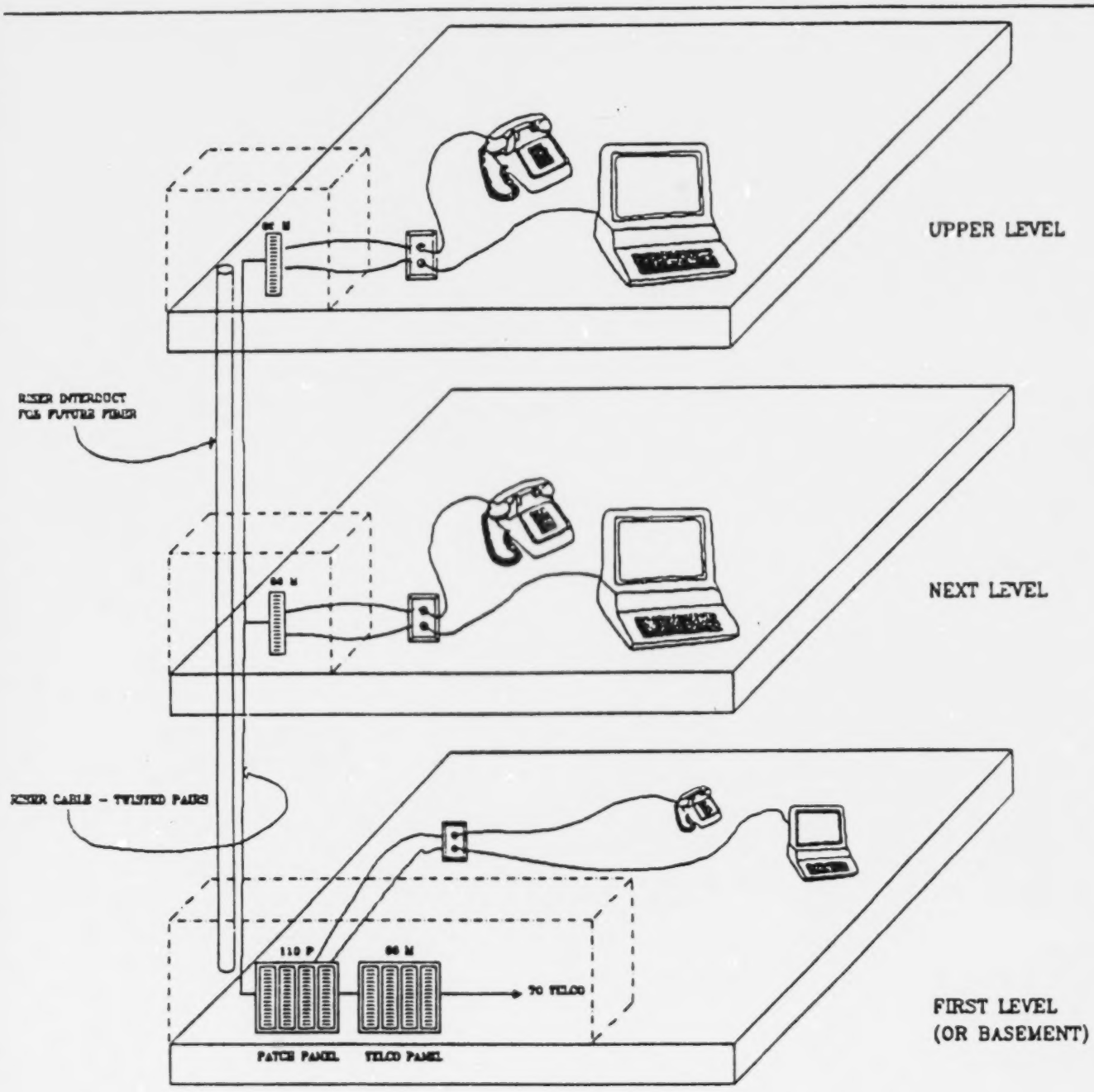



FIGURE 1

# BACKBONE (RISER) SUBSYSTEM

Source: State Telecommunications Office Guidelines.

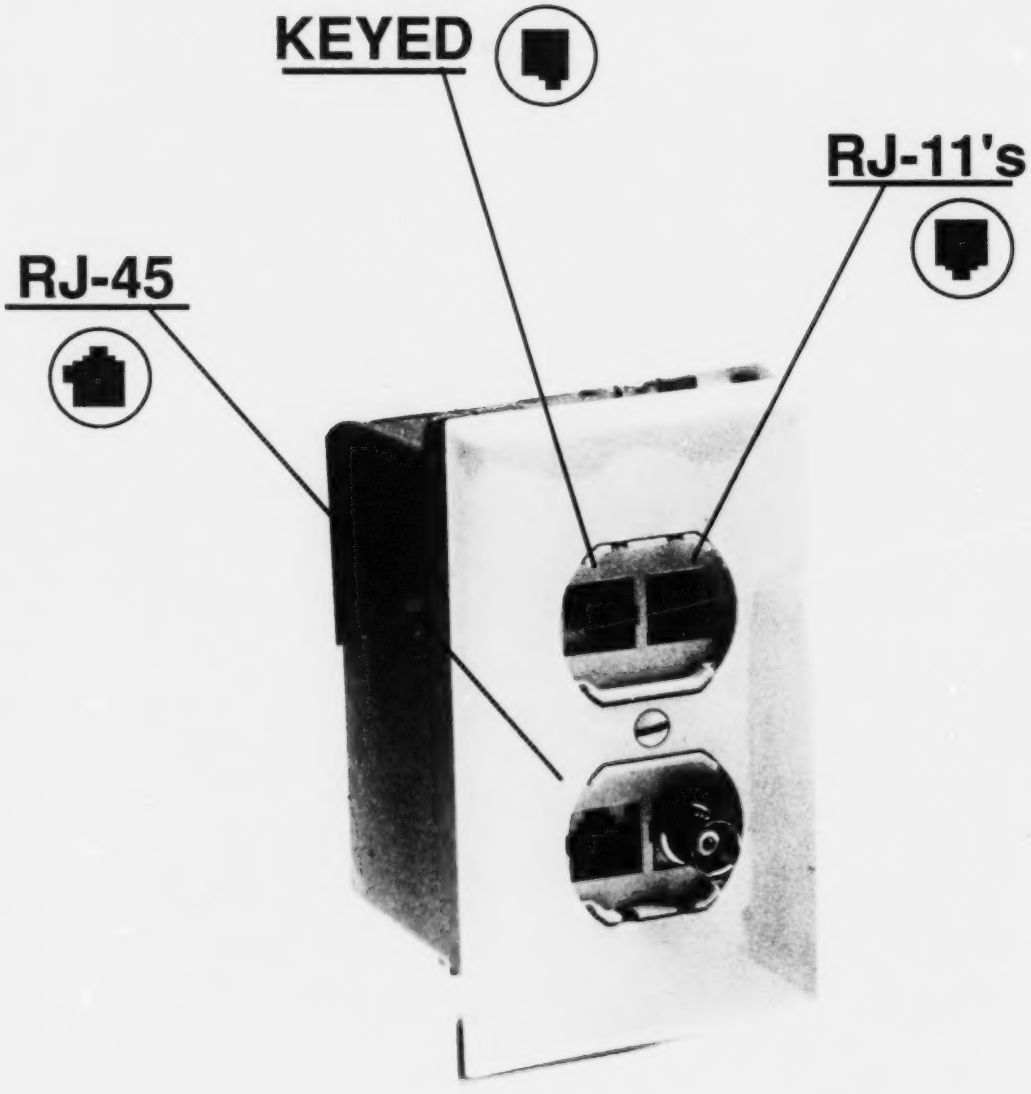



**FIGURE 2**

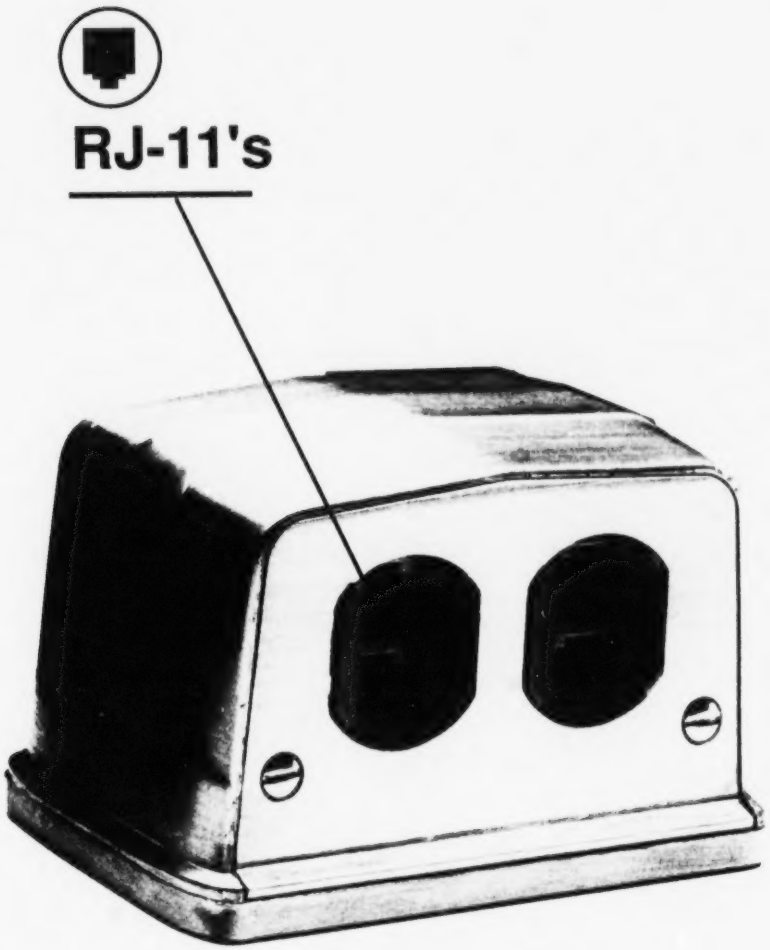



**FIGURE 3**

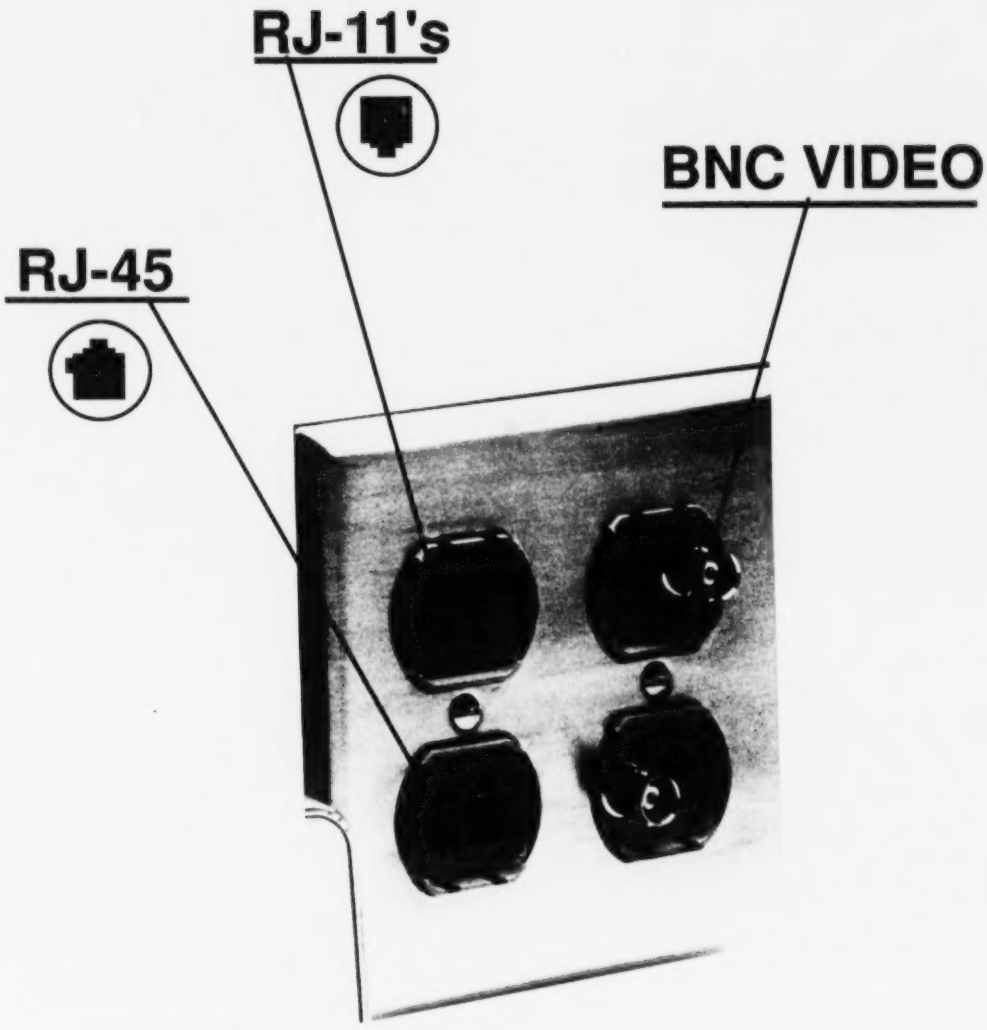
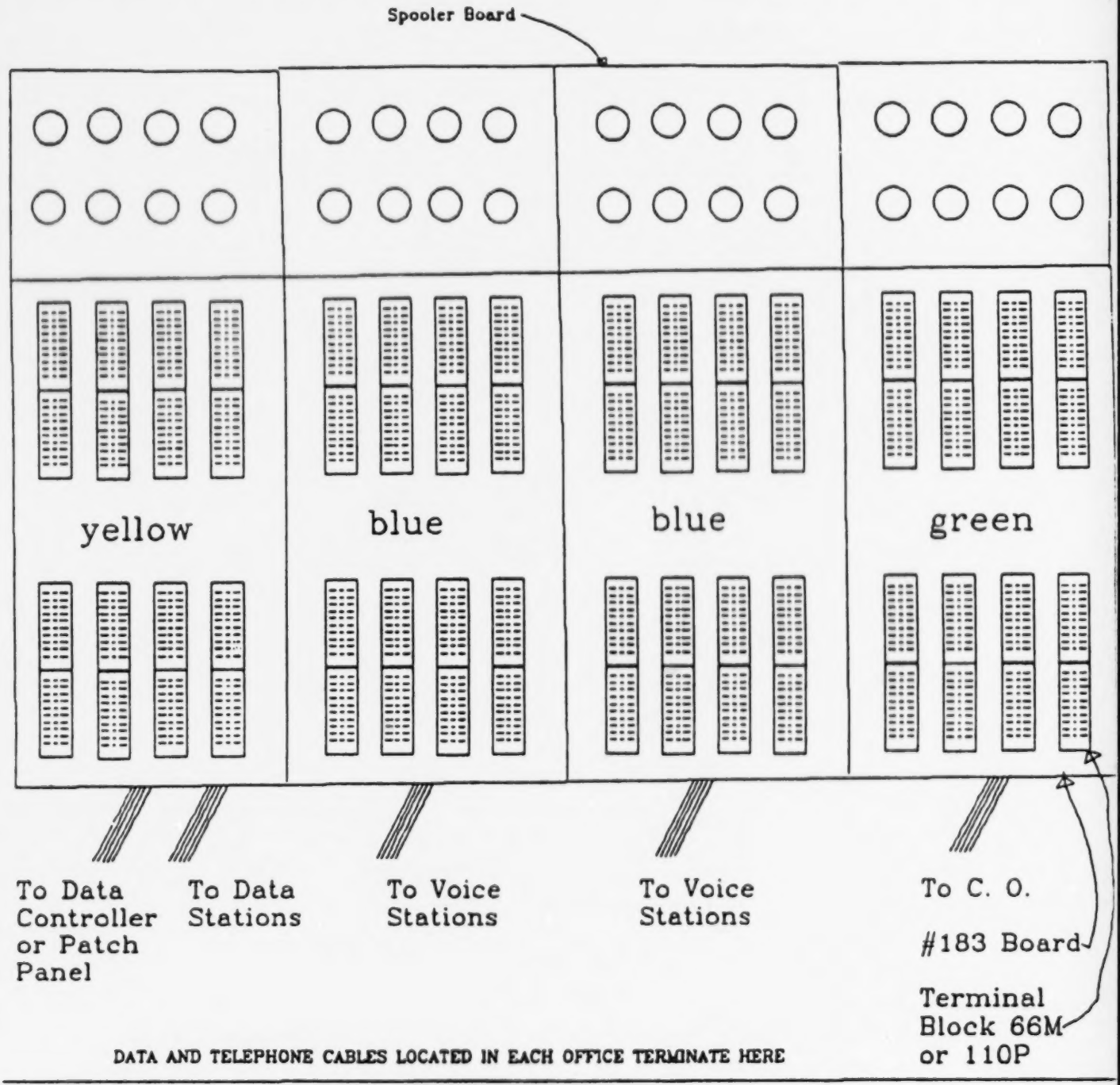



**FIGURE 4**




# FIGURE 5
# BACKBOARD ARRANGEMENT

Source: State Telecommunications Office Guidelines.

# RECOMMENDED RF TELEVISION HEADEND DESIGN

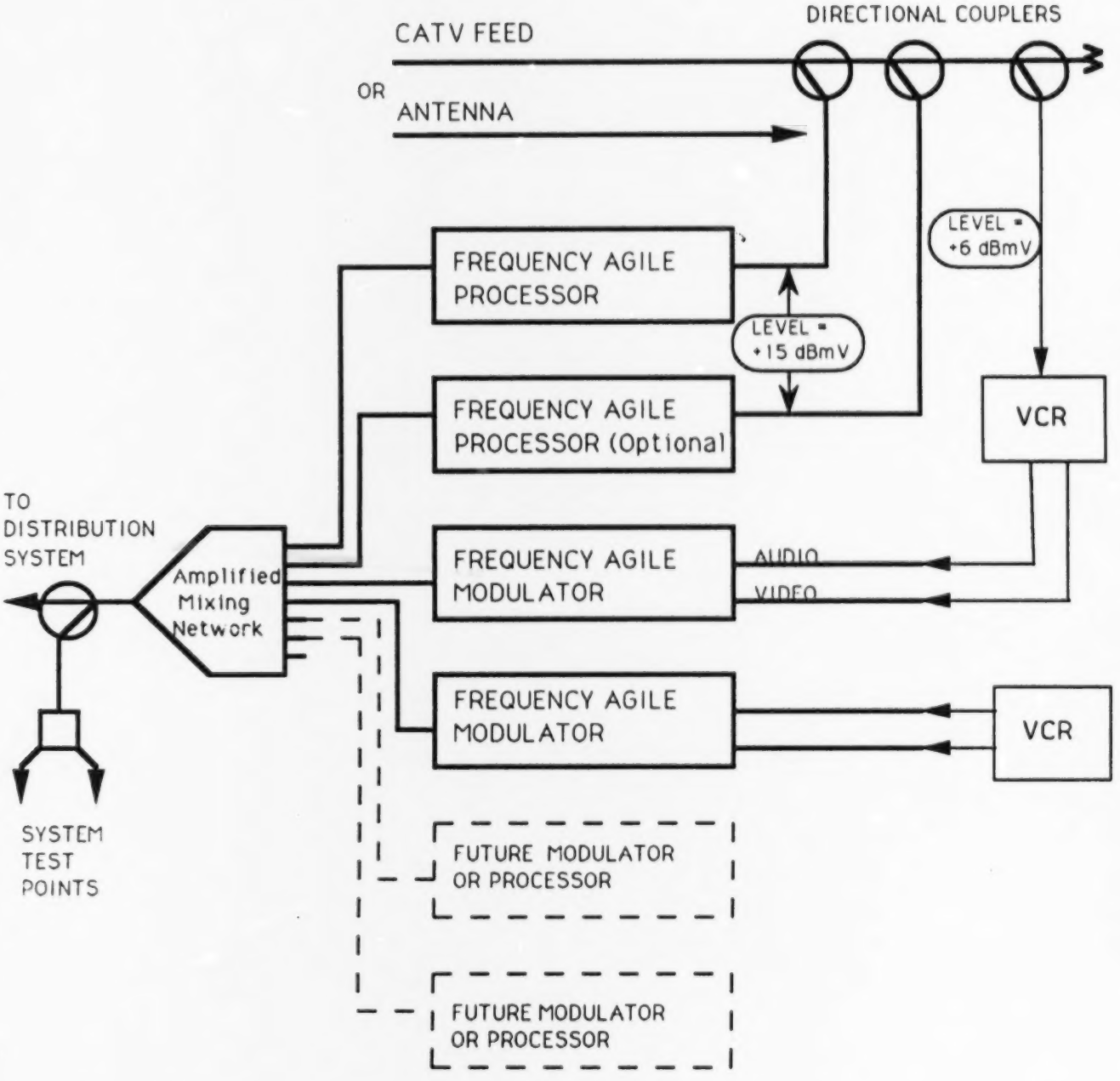



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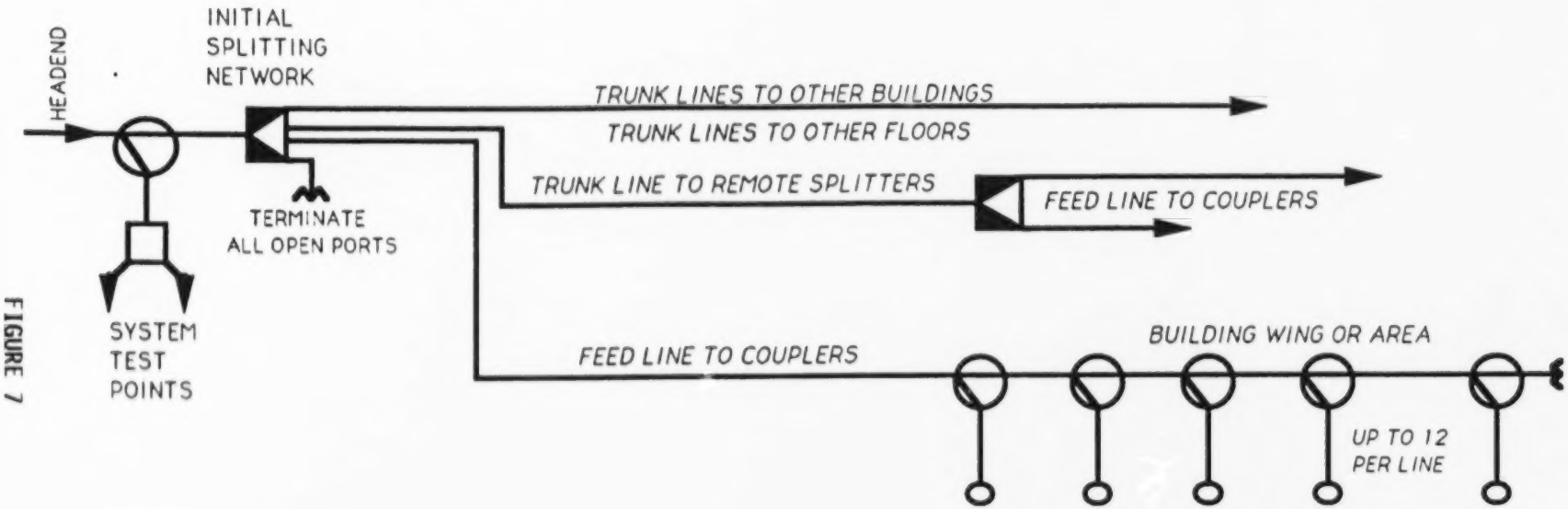
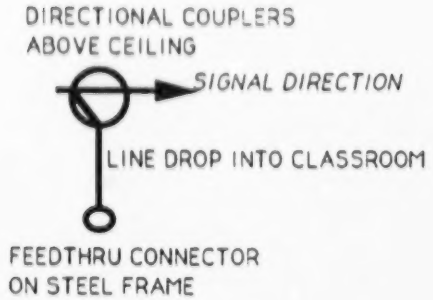
FIGURE 6

# TYPICAL RF DISTRIBUTION SYSTEM

## FOR PUBLIC SCHOOLS




CABLE:

TRUNK LINES = RG-11, RG-6 OR .500

FEED LINES = RG-6 OR .500

LINE DROPS = RG-6

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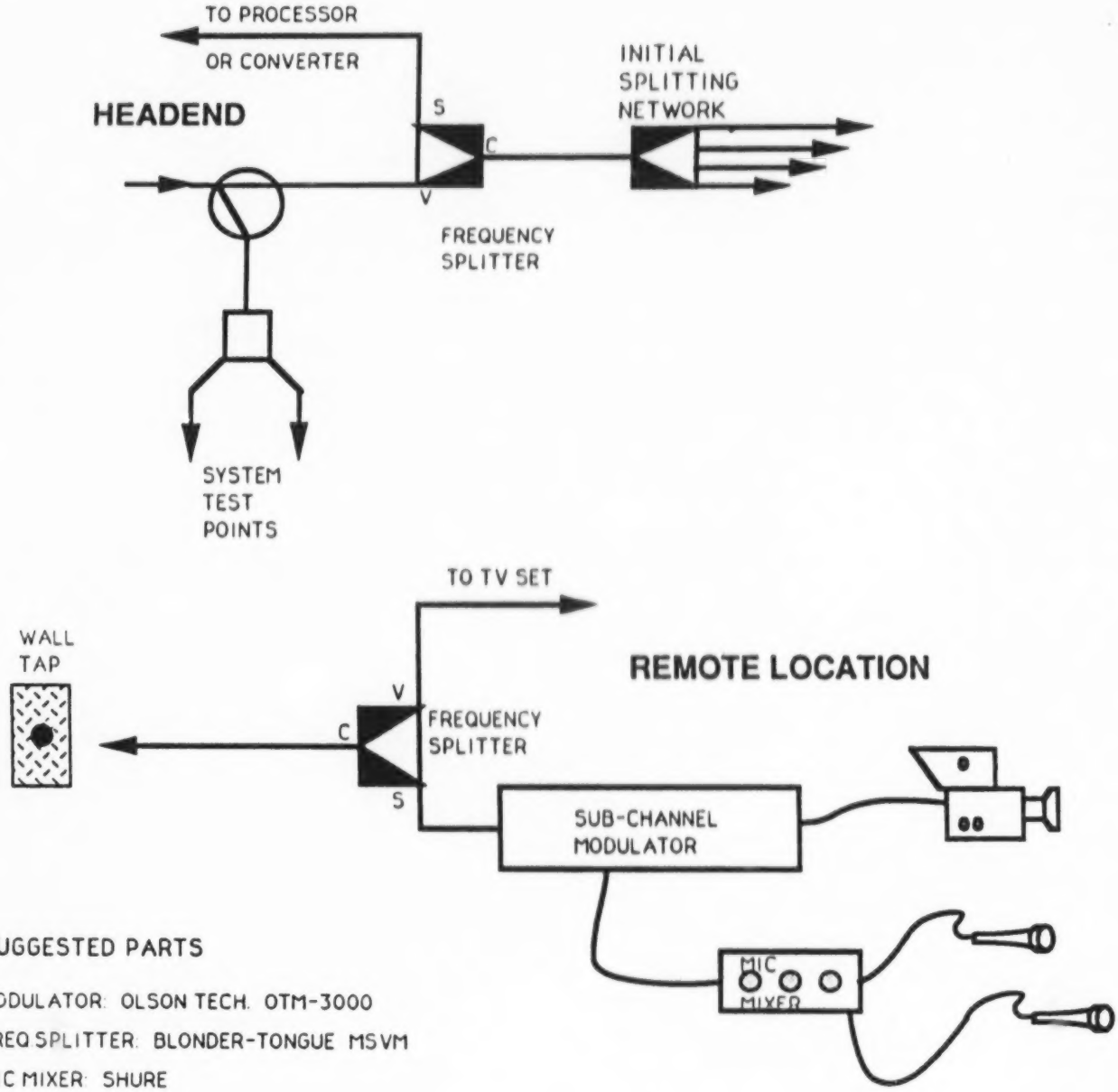
FIGURE 7

33

Version 1.1.0

# ADD-ONS FOR LOCAL ORIGINATION FROM ANY TAP IN THE SYSTEM




SUGGESTED PARTS

MODULATOR: OLSON TECH. OTM-3000

FREQ SPLITTER: BLONDER-TONGUE MSVM

MIC MIXER: SHURE



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FIGURE 8



Version 1.1.0